PATENT SPECIFICATION 1,164,281

DRAWINGS ATTACHED.

Inventor:—WILLIAM DUDLEY GILMOUR.

1,164,281

Date of filing Complete Specification: 16 Sept., 1966.

Date of Application (No. 39898/65): 18 Sept., 1965.

Complete Specification Published: 17 Sept., 1969.

Index at acceptance:—H4 U(3B, 3C); H4 L(11C, 26C4, 26C5, 26E8, 26F6, 26G1B, 26G2C).

International Classification:—H 04 b 5/00.

COMPLETE SPECIFICATION.

Improvements in or relating to Telephone User's Local Apparatus.

We, ELECTRIC & MUSICAL INDUSTRIES LIMITED, a British company of Blyth Road, Hayes, Middlesex, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to telephone-user's local apparatus of the type (hereinafter referred to as "the type specified") with which a telephone user is provided, and which can only be operational when connected by means of wires to a telephone exchange and whereby the telephone user may establish telephonic intercommunication with another telephone user.

In known arrangements, such local apparatus includes a microphone-earphone assembly in the form of a handset electrically and mechanically connected by means of a cable to a cradle unit which includes cradle means for housing the handset when not in use and which may also include other equipment as required and as convenient.

With such known arrangements, where the cradle unit is located upon a desk there is a tendency for the said cable to disturb papers upon the desk. Furthermore, the telephone user tends to be restricted to a region defined by the length of the said cable and thus may be unable for example, to carry the handset with him while he is consulting filed documents located outside of that region. It is an object of the present invention to reduce such difficulties.

According to the invention there is provided telephone user's local apparatus of the type specified, the apparatus including at least one portable microphone-earphone assembly not tethered to the remainder of the apparatus, and including intercoupling means for conveying speech signals from the or each assembly to the remainder of the apparatus and vice versa, said intercoupling means being such that the coupling in both directions is inductive.

The invention also includes a telephone system which includes at least one telephone exchange which is provided with at least one apparatus according to the invention.

In order that the present invention may be clearly understood and readily carried into effect it will now be more fully described by way of example and with reference to the drawings accompanying the Provisional Specification of which:—

Figure 1 is a block-schematic circuit diagram of a duplex inductive-loop system for carrying out the invention,

Figure 2 is a block-schematic circuit diagram of another form of system,

Figure 3 illustrates waveforms associated with the system of Figure 2,

Figure 4 is a schematic circuit diagram of a power supply system;

Figure 5 is a schematic circuit diagram of a modification of the system of Figure 2,

Figure 6 illustrates waveforms associated with the system of Figure 5,

Figure 7 is the circuit for a handset for use in the system shown in Figure 5,

Figure 8 shows another form of the circuit of Figure 7, and

Figure 9 is the circuit of the cradle-unit equipment for use with Figures 7 or 8.

Known arrangements of telephone-user's local apparatus commonly include a routing device, for example in the form of a hybrid transformer, which is so arranged that speech signals received from the telephone exchange are at least in part routed to a listen channel and thence to the earphone of the microphone-earphone as-

sembly, and which is also so arranged that speech signals received over a speak channel from the microphone of the microphone-earphone assembly are in part routed to the telephone exchange and also in part routed to the listen channel to afford a variety of feedback, termed "sidetone", whereby the telephone user hears his own speech in the said earphone, the purpose of sidetone being to give confidence to the telephone user that his said microphone is working. In apparatus according to the invention it is desirable that such sidetone facilities be present, the more so because the absence of the sidetone may be employed to indicate to the telephone user that the said intercoupling means between his cordless microphone-earphone assembly, and the remainder of his said local apparatus, is not functioning correctly, as for example because of gross misalignment in the case where that intercoupling means is directionally sensitive. The intercoupling means between one or any one microphone-earphone assembly and the said remainder of the apparatus may be in the form of a duplex system, or in the form of a pseudo-duplex system formed by a time-division simplex system. The last mentioned system may be of the kind wherein pulses are transmitted alternately in one direction and in the opposite direction.

In the embodiments to be described, it will be assumed, for simplicity of description, that the telephone user's local apparatus of the type specified has a microphone-earphone assembly in the form of a handset and has a cradle unit which includes cradle means for housing the handset when not in use. The handset is not secured by means of a cable or other means to the cradle unit, that is it is not tethered to the cradle unit so that the user may move freely after lifting the handset from the cradle unit provided of course he remains within the inductive coupling field.

Figure 1 illustrates a case where the said intercoupling means has the form of a duplex system, is based upon an inductive link including an inductive loop 4, and employs carrier frequencies of the order of 20—50 Kc/s or more.

Inductive loops are simple, easy to install, and robust in service. The listen channel is derived from the conventional hybrid transformer 1 in the cradle unit, the speech being amplified in amplifier 2 and used to modulate the output of an oscillator 3 either in amplitude or frequency. After further amplification if necessary, the modulated output, at a frequency or frequencies denoted by f_1 is applied to the fixed inductive loop 4 which is laid to extend around the region within which the handset is to be used. This signal is received on a ferrite-rod inductive pick-up winding 5 at the handset, passed through a band pass filter 6 accepting f_1, amplified in amplifier 7, detected in demodulator 8 and applied to the handset earphone 9. Speech from the handset microphone 10, is applied to a similar oscillator/modulator, operating at a frequency or frequencies denoted by f_2, and the output applied to the winding 5. This signal is picked up in the fixed loop 4, filtered from f_1 in a suitable band pass filter 12 and after amplification in the amplifier 13 and demodulation in the demodulator 14, is applied to the speak channel of the hybrid transformer 1 which allows some feedback to give sidetone.

A duplex system of this type depends critically on the efficiency of the band pass filters 6 and 12 in separating f_1 from f_2. The interaction between the loop 4 and the winding 5 is reciprocal, and, experience has shown that a 1 mV signal can be coupled from a suitable loop 4 at 20 Kc/s by means of a 0.1A current in the loop, across whose terminals is a potential of about 1V. Thus the filters must separate f_1 and f_2 with a differential of at least 60 dB, and preferably 80 dB, to allow for orientation losses and so on. If f_1=20 Kc/s say, and f_2=50 Kc/s, this separation should be possible with a three stage filter, which can be augmented by tuning the predetection amplifiers 7 and 13 although the bulk of the filtering must be done before amplification to avoid cross-modulation difficulties in a simple amplifier. AGC represented by 15 and 16 will be needed for an AM system, but may well be unnecessary for an FM system.

Normal design techniques may be applied to this kind of system provided that sufficient separation between f_1 and f_2 can be given. Other channels can be obtained by a suitable choice of carrier frequencies. The field from the loop 4 is fairly well defined horizontally by the confines of the loop when horizontal, but there will be some stray vertical field, extending roughly to a height equal to the diameter of the loop. The field from the winding 5 will be less well defined, and thus although it would be possible for two adjacent installations to use the same f_1, it would be unwise for them to share f_2, unless an FM system were used in which the capture effect would operate. The range of such a system depends thus on the confines of the loop and anywhere within the loop would give a usable signal provided no magnetic screening material is present.

In order to avoid the difficulties posed by the filters 6 and 12 required above a simple pulse-width-modulation system may be employed. Such a system is shown in Figure 2, and the waveforms present at the lettered parts thereof are indicated in Figure 3. A master time base in the form of an

oscillator 17 is provided in the cradle unit and it generates uniformly spaced pulses (at a repetition rate of 50 Kc/s) which trigger a first bi-state circuit in the form of the monostable multivibrator circuit 18, whose ON time is modulated by the amplified listen signal. The loop 4 is fed directly from the output signal of the monostable 18. This output signal is inhibited from passing into the amplifier 13 during the ON period by the AND gate 19. A differentiated version of the waveform B will be picked up by the winding 5 in the handset. This is amplified in amplifier 7 and fed to a second bi-state circuit in the form of a bistable trigger circuit 20 which turns ON for a positive pulse and OFF for a negative one. The output from the circuit 20 shown by waveform D is thus a replica of waveform B. A low pass filter 21 gives an audio output, fed to the earphone 9. The leading edge of waveform D, which is fixed in time by the waveform A from the timing oscillator 17, is delayed in delay circuit 22 and used to trigger ON a monostable circuit 23 identical to that in the cradle unit, but modulated in this instance by the output from the microphone 10. The output waveform F is applied to the winding 5 and a differentiated version thereof (waveform G) is picked up by the loop 4, amplified in amplifier 13 and passed to a bistable trigger circuit 24 (identical to 20) of which the output is smoothed by the LP filter 25 and passed via amplifier 31 to the hybrid transformer 1 as the speak signal. Sidetone is provided by the hybrid transformer 1 as before. The receiving amplifier at the handset is inhibited for the duration of the transmitted pulse at that end by the AND gate 26. This type of circuit may readily be realised in integrated circuit blocks, and can thus be made far more compact than the system shown in Figure 1. If several non-interacting channels are required the transmitted waveforms B and F can be impressed on a suitable carrier frequency of the order of 500 Kc/s. However, if some increase in noise can be tolerated, it should be pointed out that what amounts to synchronous demodulation has been established, since the frequencies of different timing oscillators 17 can be staggered, and thus reasonable performance should be possible with adjacent sets of apparatus provided that the required signals are stronger than the interfering ones. Some economy in power consumption may be obtained by differentiating B and F before applying these waveforms to the loop 4 and the winding 5 respectively.

It should be noted that the fixed loop 4 may be replaced by a long ferrite-rod aerial of a length of about 18 inches; however, in a fixed installation the loop may be more easily concealed.

In passing it might be considered that one channel could use the voice-frequency currents directly. This is not so because of the differentiating effects of the loop 4 and of the winding 5 and the consequent liability to saturation by 50 c/s signals or harmonics thereof from the public electricity supply mains due to the very high low-frequency gain required.

Figure 4 shows schematically the arrangement of a suitable power-supply arrangement for taking a small current from the line and using it to recharge a suitable storage battery 29 located inside the handset, via contacts 27 which may be made while the handset is housed by the cradle means. The bridge rectifier 28 serves to connect the line DC to the storage battery 29 with the correct polarity irrespective of which way round the handset is positioned on the cradle means. The transistor Q1 is provided to otherwise disconnect the battery 29 from the handset apparatus (for example the elements 26, 7, 20, 22, 23 and 10 of Figure 2) when the handset is replaced on the cradle means, the transistor Q1 being then biassed to cut-off via the centre contact 30. While a current of about 10 mA may be drawn from the exchange line without operating the exchange relay it is quite likely that that relay will not drop out unless the current is reduced below this level; the condenser C1 with associated resistor R_1 are therefore provided to supply current to the handset immediately on replacement, the arrangement being such that the line current falls momentarily nearly to zero on replacement of the handset.

A bridge rectifier, not shown, may also be required at the input from the line to the power-supply arrangement to allow for the polarity of the exchange line to be reversed during maintenance operations on the line or at the exchange. Alternatively, a local power supply, of conventional design, fed from the 50 c/s public electricity supply mains, may be installed within the cradle unit.

The block schematic of an alternative embodiment is shown in Figure 5 and the waveforms present at the lettered parts thereof are indicated in Figure 6. In the cradle unit, a train of timing pulses is generated at a constant rate by a unijunction-transistor type of timing oscillator 32. These pulses trigger a monostable multivibrator circuit 18, whose ON time is modulated by the listen signal from the hybrid transformer 1. After amplification in amplifier 33 the output from the multivibrator is applied to a loop 4 encircling the area in which it is desired to use the handset. The loop waveform is picked up in differentiated form by the winding 34 on the ferrite rod 5 in the handset, and the start pulse, which is

positive, is amplified in the gated amplifier 35 and switches ON a bistable circuit 36. The finish pulse, which is negative, switches OFF the bistable circuit 36. The output from the bistable circuit 36 is thus a replica of the current in the loop 4, and may be passed through a low pass filter 21 and, after subsequent amplification in amplifier 37, applied to the earphone 9 of the handset. The trailing edge of the bistable waveform D_1 triggers a monostable multivibrator circuit 23, whose ON time is modulated by the output from the microphone 10 in the handset. The trailing edge of the output from the monostable circuit 23 is differentiated by condenser 38, the resulting pulse being amplified in amplifier 39 and applied to a second winding 40 on the ferrite rod 5 in the handset. A corresponding pulse is picked up by the loop 4 and, after amplification in the gated amplifier 41, resets to its OFF state a bistable circuit 42 in the cradle unit, which bistable circuit has already been set to its ON state by the trailing edge of the pulse from the monostable circuit 18. The output from the bistable circuit 42 is thus a replica of the output from the monostable circuit 23 in the handset, and thus, after filtering in the low pass filter 25 and audio amplification in amplifier 31, the signal may be applied to the hybrid transformer 1 as the speak signal. At both ends of the link, the receivers are desensitised during, and for a short period following, their respective transmitting periods by applying blocking signals to the gated amplifiers 35 and 41 via pulse stretching networks 43 and 44, with a time constant of 10μsec. The basic pulse repetition rate used is 10 kc/s and the monostable-circuit outputs last for 10—30 μsec in each case. The receivers are desensitised for about 10 μsec after the end of their respective pulses.

Figure 7 shows the circuit of a handset suitable for use in the system shown in Figure 5.

A common ferrite rod 5 of grade A4 is used for both paths, although separate windings L1A and L1B on the rod are used. The signal from the loop 4 surrounding the room is picked up by L1A, limited (to prevent damage from the handset transmitted pulse) by the diodes D1 and D2, and amplified in the four-stage common emitter transistor type of amplifier Q1—Q4. Additional limiting along the chain is provided by diodes D3 and D4 which give substantially 100% feedback to stage Q2 for strong signals. During the pulse E_1 generated within the handset, and for about 10 μsec thereafter, the output is effectively earthed by diode Q5. The bistable circuit 36 is formed by a tunnel diode, D5, which is held in its low-current state for the duration of the pulse E_1 and restored to its high-conduction state by the incoming pulse from the loop 4. The tunnel diode D5 is reset into the low-current state by the second differentiated edge of the received pulse, which edge is positive at the tunnel diode. The output from the tunnel diode D5 is amplified in stage Q7. The negative output from this stage, corresponding to the end of the received pulse, fires the monostable circuit 23 afforded by stages Q9, Q10. The negative-going output from Q10 is stretched by the diode D6 and its associated circuit, and this output is used for suppression of the receiver and for holding the tunnel diode D5 in its low-current state, by transistors Q5 and Q6 respectively. At the end of the handset pulse E_1, whose duration is controlled by the output from the moving-coil microphone 10 in the handset amplified by stages Q13 and Q12, the positive pulse from differentiating the output of stage Q10, is applied to stage Q11, which thereby conducts heavily and passes a pulse of current into winding L1B on the ferrite rod 5, thus generating the handset pulse F_1, which is picked up by the loop 4 surrounding the room. The output from Q7 is also passed through a low pass filter and a simple audio amplifier, stage Q8, to feed the earphone 9.

Figure 8 shows the circuit of a handset which incorporates integrated circuit elements manufactured by the Texas Instrument Company of America. Integrated circuit amplifiers and logical elements are used, although the operating conditions chosen, because of the limited battery voltage, are often outside those recommended by the manufacturer. The circuits represented in Figure 8 are:—

N_1 and N_2	Video Amplifiers;
N_3	Bistable;
N_4	Monostable;
N_5	Microphone Amplifier;
N_6	Earphone Amplifier;

The battery is switched on, in this embodiment, by means of a reed relay of the normally closed type, which is operated by a permanent magnet on the cradle unit. Built-in battery charging is not provided in this circuit, although it may readily be added.

In Figure 8, networks N1 and N2 form the amplifier for the received pulses. The amplifier is desensitised by stage Q2, driven from the stretched transmitted pulse as before. Stage Q1 at the output of N2 is required to produce sharp-edged pulses for driving the bistable element N3, which is set on its 'preset' terminal, and reset by clock pulse. N6 is an audio amplifier driving the earpiece. Use has been made of the frequency shaping terminals to give an 18 dB/octave roll-off for carrier stripping.

N4 is the handset monostable, modulated by the output of the handset microphone, amplified in N5. Q3 and Q4 form a similar output circuit to that described above. The power lines are +5, +3, and −5V derived by Zener diodes 45 and 46.

Figure 9 shows the circuit diagram of the cradle-unit equipment which employs similar integrated circuits in the form of a type SN518A monostable circuit N_7 and a type SN 511A bistable element, N_8. The basic timing pulses are derived from the uni-junction transistor oscillator, Q1, which drives the monostable network N_7 whose output is amplified in stages Q2 and Q3 and drives the loop 4 laid round the room. Modulation for network N_7 is obtained from line, through a d.c. blocking capacitor 47 and the level may be adjusted by potentiometer RV 1. Signals from the loop are amplified in the conventional amplifier stages Q4—Q6, with stage Q7 providing suppression during the transmitted pulse. The transistor of the stage Q6 is normally bottomed, and the received signals from the handset is a negative pulse, applied to the network N_8, which has previously been set at the end of the pulse transmitted by the cradle unit. The output from N_8 is smoothed and amplified, before being passed back to line through the hybrid transformer within the cradle unit. A direct connection to the normal handset may be made through switch SW1A and SW1B so that the telephone can still be used normally if the cordless handset is removed for battery charging etc. This facility is also an aid to preserving a relative secrecy in communication. The power supply circuits may be conventional, or the equipment may be powered from the exchange battery. A good radio-frequency earth through capacitor C1 is necessary.

There will normally be no interference between adjacent sets of apparatus, provided that the corresponding loops 4 are separated by more than one loop diameter. With smaller separations, the possibility of interference will depend on such factors as the precise control of pulse repetition rate and so on, although if the pulse repetition rates of adjacent installations are locked, as can be done very simply, the possibility of interference will be much reduced. On any one installation, any number of handsets may be used and an hierarchic system of reply can be used, with users of greater priority being provided with handsets with shorter retransmission delay times, for the handset with the shortest delay time will capture the cradle-unit receiver. It will be understood that voice-operated switching of the handset transmitter will then be necessary.

Modifications may be readily made to the described embodiments within the scope of the invention. The battery charging circuit shown in Figure 4 may be modified to act by way of an electromagnetic coupling between the cradle unit and the handset in the form of a transformer in the cradle unit energised by a periodic supply. Such an arrangement would overcome any difficulty arising from a bad contact between the cradle means or cradle unit and the handset during the recharging period.

The alternative forms of the said intercoupling means, employing an optical-frequency link or an ultrasonic link, have been referred to and both these systems have the advantage that the transmit and receive paths both at the cradle unit and at the handset may be more readily decoupled, thus easing the problem of speak-listen channel separation. A said combination of different links will also show an advantage in this respect.

WHAT WE CLAIM IS:—

1. Telephone user's local apparatus of the type specified, the apparatus including at least one portable microphone-earphone assembly not tethered to the remainder of the apparatus, and including intercoupling means for conveying speech signals from the or each assembly to the remainder of the apparatus and vice versa, said intercoupling means being such that the coupling in both directions is inductive.

2. Apparatus according to Claim 1 wherein the or each portable microphone-earphone assembly is in the form of a handset.

3. Apparatus according to Claim 1 or 2 wherein the said remainder of the apparatus includes cradle means for cradling the assembly or at least one of the assemblies, when not in use.

4. Apparatus according to Claim 1, 2 or 3 wherein said intercoupling means provides a duplex system of communication between the or each assembly and the remainder of the apparatus.

5. Apparatus according to Claim 1, 2 or 3 wherein said intercoupling means provides a pseudo-duplex system of communication, in the form of a time division simplex system of communication, between the assembly or at least one of the assemblies, and the remainder of the apparatus.

6. Apparatus according to any preceding claim including means for providing said speech signals to said intercoupling means in the form of pulses.

7. Apparatus according to Claim 6 wherein said speech signals are provided in the form of width modulated pulses.

8. Apparatus according to any of Claims 1 to 6 wherein said speech signals are provided in the form of pulses the times of occurrence of which are varied.

9. Apparatus according to any preceding claim wherein said coupling means includes a loop of electrical conductor which extends from said remainder of the apparatus around a region within which the or each assembly is intended to be used.

10. Apparatus according to Claim 9 wherein said coupling means further includes a winding on a ferrite core provided in the or each assembly.

11. Apparatus according to Claim 6 wherein said means for providing speech signals in the or each assembly and in the remainder of the apparatus includes respective bistate circuits, so arranged that the time for which a respective bi-state circuit remains in one of its two states is determined by the speech signals to be transmitted.

12. Apparatus according to Claims 5 and 6 including master timing means in the remainder of the apparatus for ensuring that pulses are transmitted only one at a time.

13. Apparatus according to Claim 3 or any claim dependent upon Claim 3, wherein the or at least one of the assemblies includes a rechargeable battery, and wherein that assembly and the cradle means are so provided with co-operating electrical contacts or coupling means that the battery can be charged, by current derived from the said remainder of the apparatus, while that assembly is cradled by the cradle means.

14. Apparatus according to Claim 13, wherein the charging circuit derives current from the telephone exchange.

15. Apparatus according to Claim 14, wherein the charging circuit includes a drop-out circuit so arranged that the said current derived from the telephone exchange is, immediately after the or at least one of the assemblies is housed in the cradle means to terminate a telephone call, less than a predetermined value.

16. Apparatus according to Claim 13, wherein the charging circuit derives current from the public electricity supply mains.

17. Apparatus according to any preceding claim in which means are provided for achieving communication from the said remainder of the apparatus to the microphone-earphone assembly or to at least one of these assemblies by modifying the timing of transitions relative to instants determined by a time base circuit and for achieving reverse communication from that assembly to the said remainder of the apparatus by modifying the timing of transitions relative to said instants or said first mentioned transitions.

18. Telephone user's local apparatus, substantially as specifically described herein with reference to the drawings accompanying the Provisional Specification.

19. A telephone system which includes at least one telephone exchange which is provided with at least one apparatus according to any one of Claims 1 to 18.

A. B. LOGAN,
Chartered Patent Agent.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon), Ltd.—1969.
Published at The Patent Office, 25 Southampton Buildings, London, W.C.2,
from which copies may be obtained.

1164281 PROVISIONAL SPECIFICATION
6 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

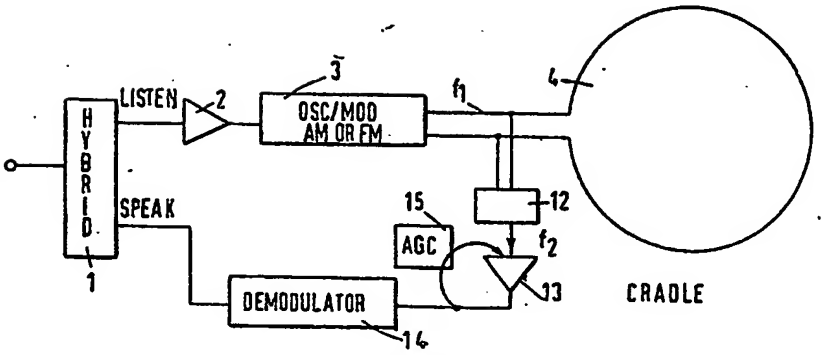


FIG. 1

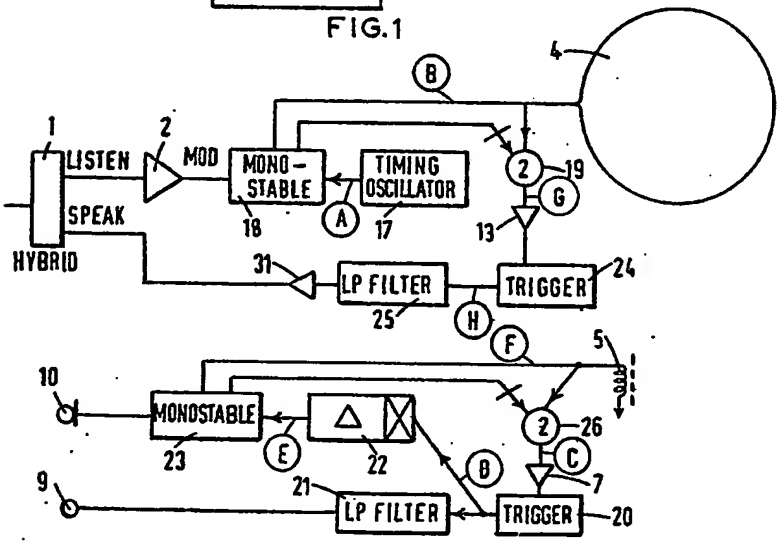


FIG. 2

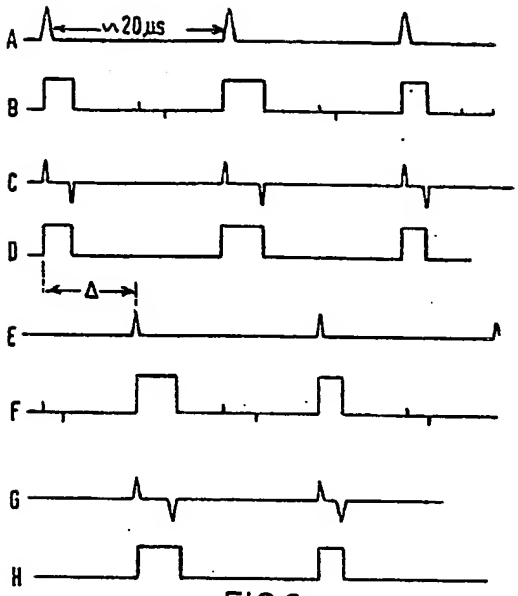

A
~20μs
B
C
D
Δ
E
F
G
H

FIG.3

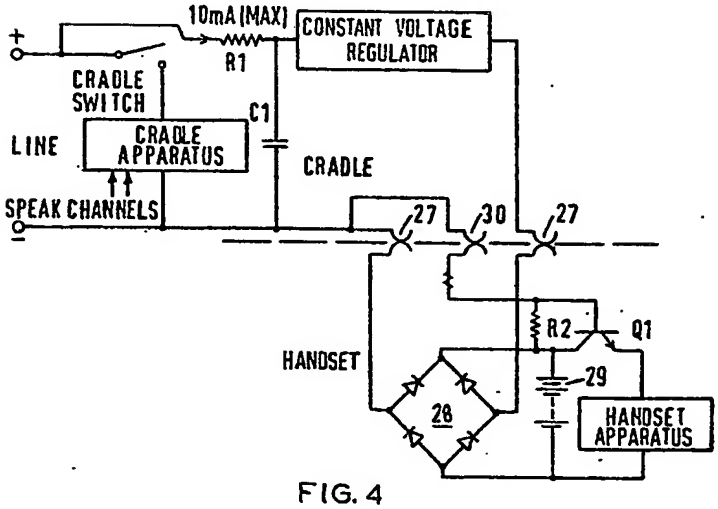

10mA (MAX)
CONSTANT VOLTAGE REGULATOR
R1
+
CRADLE SWITCH
C1
LINE
CRADLE APPARATUS
CRADLE
SPEAK CHANNELS
−
27
30
27
R2
Q1
HANDSET
29
28
HANDSET APPARATUS

FIG. 4

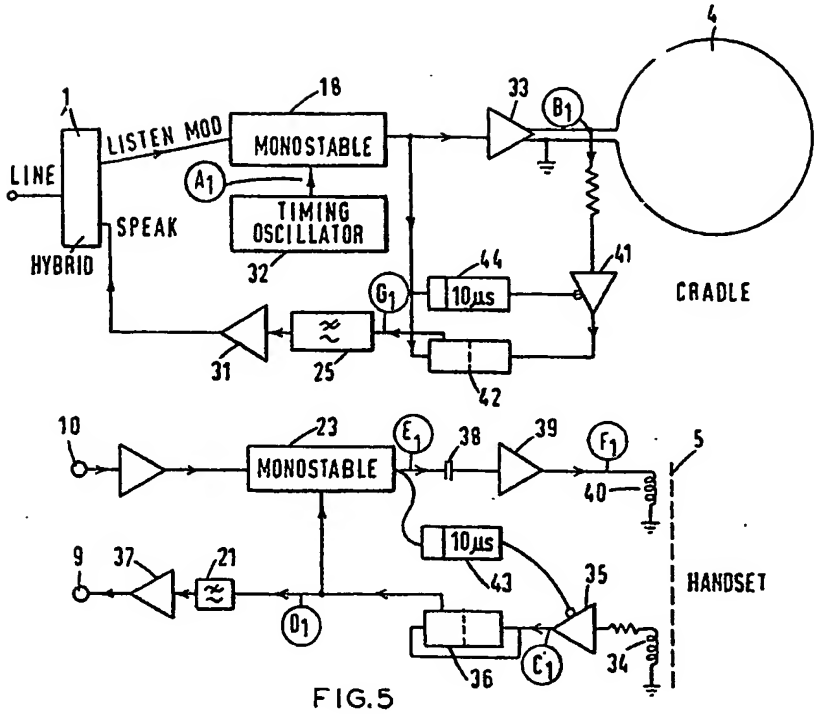

4
1
18
33
B_1
LISTEN MOD
MONOSTABLE
LINE
A_1
TIMING OSCILLATOR
SPEAK
HYBRID
32
44
41
G_1
10µs
CRADLE
31
25
42
10
23
E_1
38
39
F_1
5
MONOSTABLE
40
10µs
9
37
21
43
35
HANDSET
D_1
C_1
34
36

FIG.5

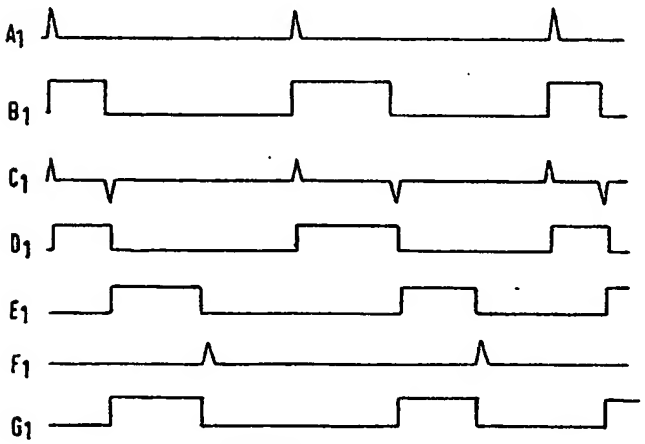
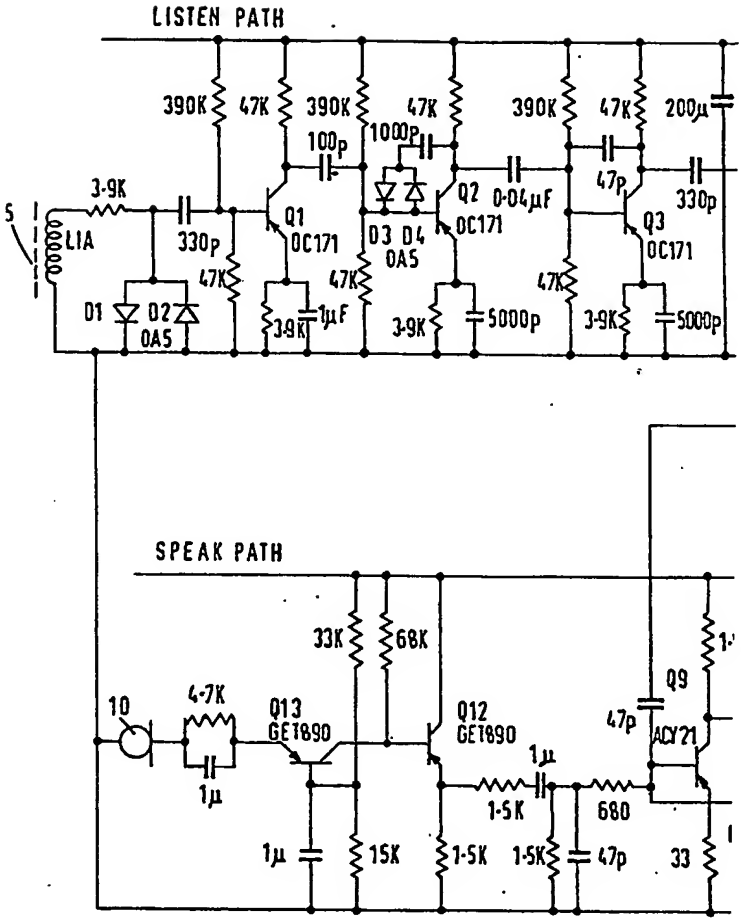

A_1
B_1
C_1
D_1
E_1
F_1
G_1

FIG.6


LISTEN PATH
390K
47K
390K
47K
390K
47K
200µ
100p
1000p
47p
330p
3·9K
Q1
OC171
Q2
0·04µF
Q3
OC171
5
L1A
330p
D3 D4
OA5
D1
D2
OA5
47K
47K
47K
47K
3·9K
1µF
3·9K
5000p
3·9K
5000p
SPEAK PATH
33K
68K
10
4·7K
Q13
GET890
Q12
GET890
Q9
47p
ACY21
1µ
1·5K
680
1µ
15K
1·5K
1·5K
47p
33

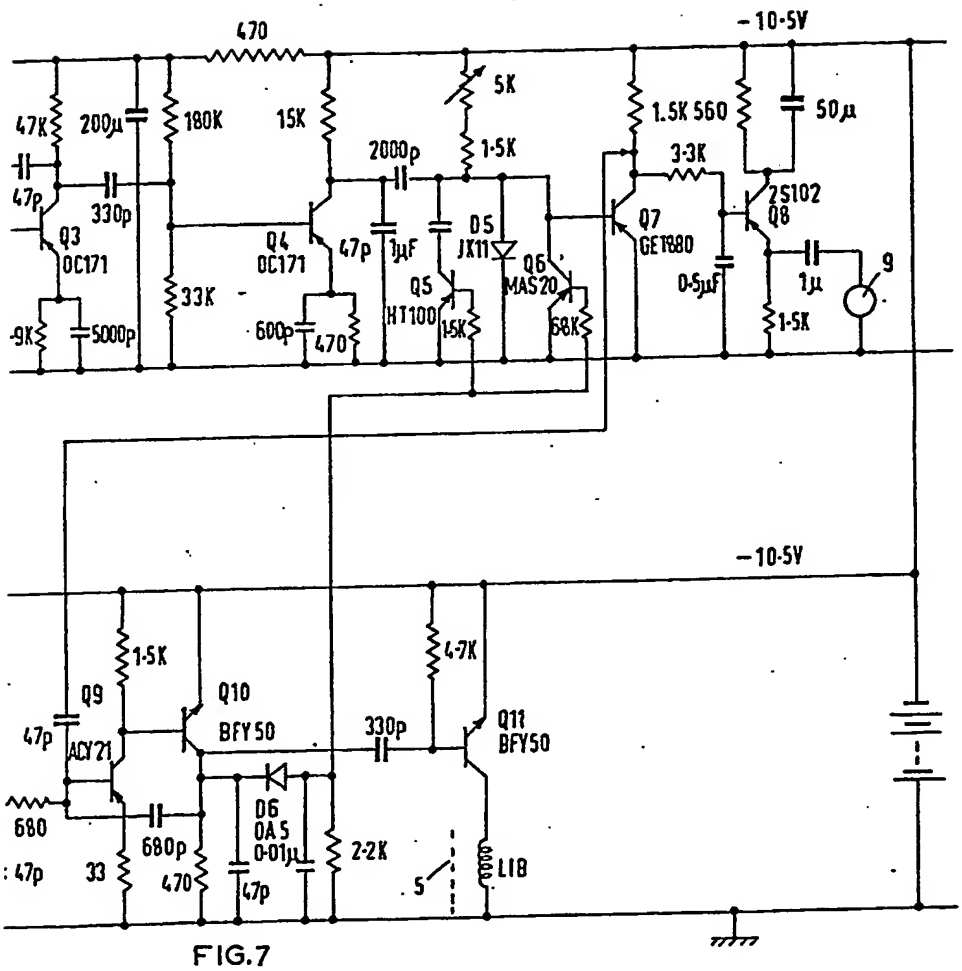

470
-10·5V
47K
200µ
180K
15K
5K
1·5K
2000p
1·5K 560
50µ
3·3K
47p
330p
Q3
OC171
Q4
OC171
47p
1µF
D5
JX11
Q6
MAS20
Q7
GET880
2S102
Q8
0·5µF
1µ
9
33K
9K
5000p
600p
470
Q5
HT100
1·5K
68K
1·5K
-10·5V
1·5K
Q9
47p
ACY21
Q10
BFY50
330p
4·7K
Q11
BFY50
680
680p
D6
OA5
0·01µ
2·2K
47p
33
470
47p
5
L18

FIG.7

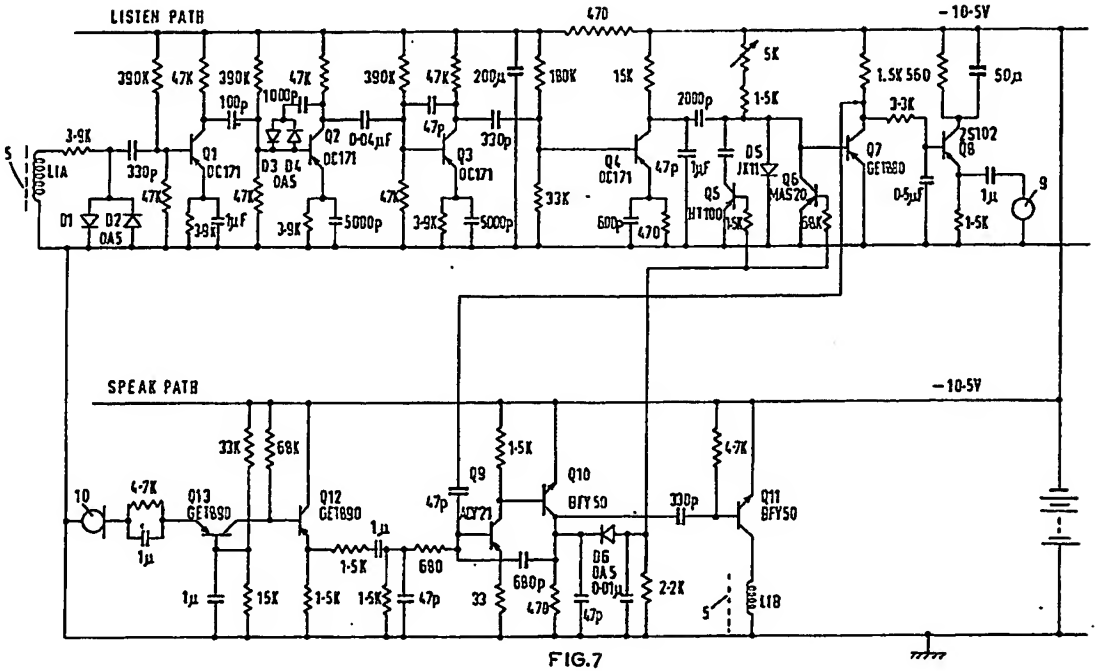
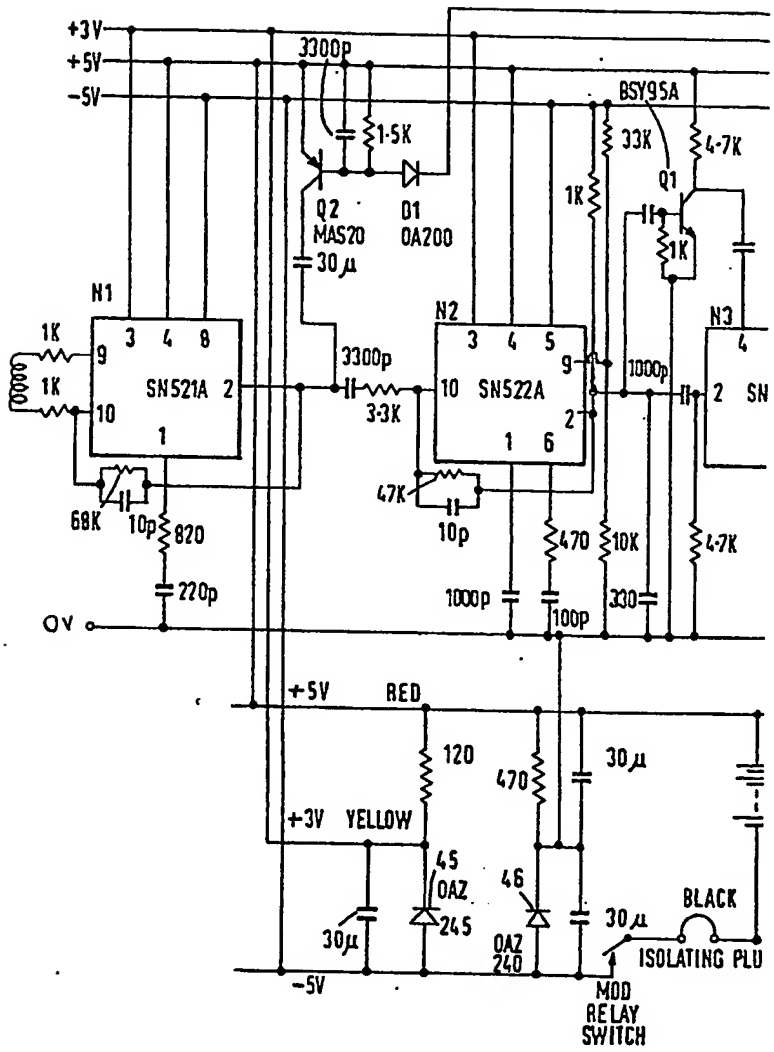

LISTEN PATH
SPEAK PATH
-10·5V
470
5K
1·5K
2000p
1·5K 560
50µ
3·3K
2S102
Q8
Q7
GET880
0·5µF
1µ
1·5K
9
LIA
S
3·9K
330p
Q1
OC171
390K
47K
100p
D1
D2
OA5
1µF
D3 D4
OA5
1000p
Q2
OC171
0·04µF
3·9K
5000p
Q3
OC171
47p
200µ
180K
33K
Q4
OC171
15K
47p
1µF
Q5
JK111
Q6
MAS20
68K
600p
470
Q5
HT100
1·5K
10
4·7K
1µ
Q13
GET880
33K
68K
15K
Q12
GET880
1µ
1·5K
1·5K
1·5K
47p
680
Q9
OC171
47p
33
680p
470
Q10
BFY50
D6
OA5
0·01µ
47p
330p
4·7K
Q11
BFY50
2·2K
S
L18

FIG.7


+3V
+5V
-5V
3300p
1·5K
Q2
MAS20
30µ
D1
OA200
BSY95A
33K
4·7K
Q1
1K
1K
N1
N2
N3
1K
1K
SN521A
SN522A
3300p
3·3K
1000p
47K
10p
68K
10p
820
220p
470
10K
4·7K
1000p
100p
330
0V
+5V
RED
120
470
30µ
+3V
YELLOW
45
OAZ
245
46
OAZ
240
30µ
30µ
BLACK
ISOLATING PLU
-5V
MOD
RELAY
SWITCH

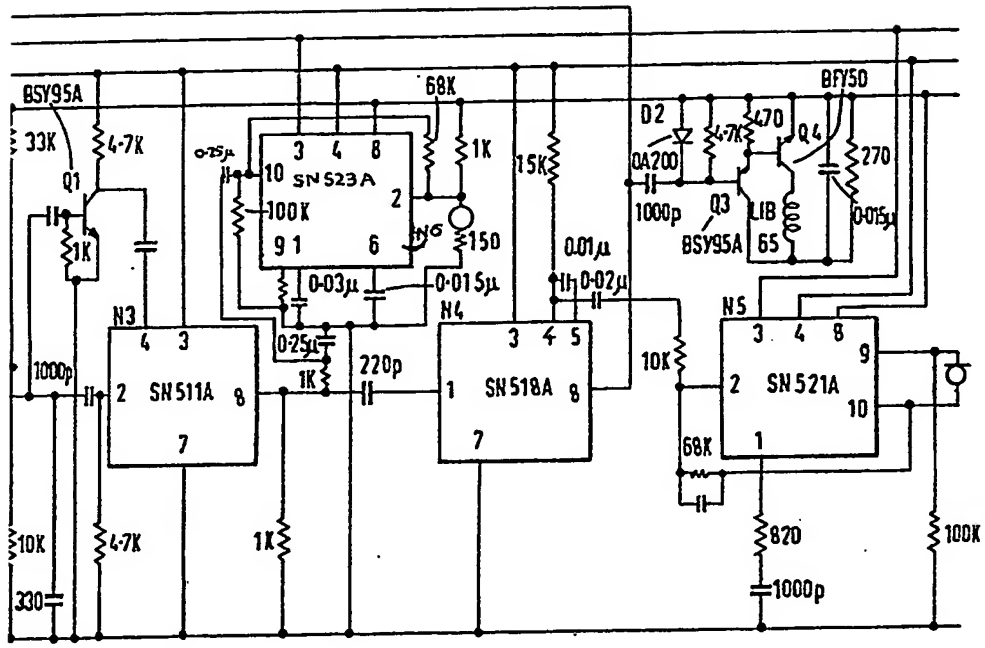
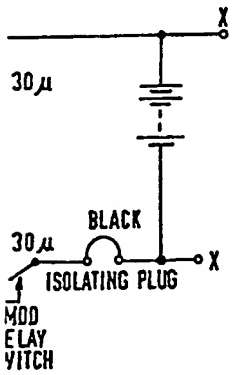

BSY95A
33K
4·7K
Q1
1K
10K
330
1000p
N3
SN511A
0·25μ
100K
SN523A
68K
1K
150
0·03μ
0·015μ
N6
15K
0·01μ
0·02μ
N4
SN518A
220p
1K
4·7K
D2
OA200
1000p
Q3
BSY95A
BFY50
470
4·7K
Q4
LIB
65
270
0·015μ
N5
SN521A
10K
68K
820
1000p
100K

FIG. 8


X
30μ
BLACK
30μ
X
ISOLATING PLUG
MOD
ELAY
YITCH

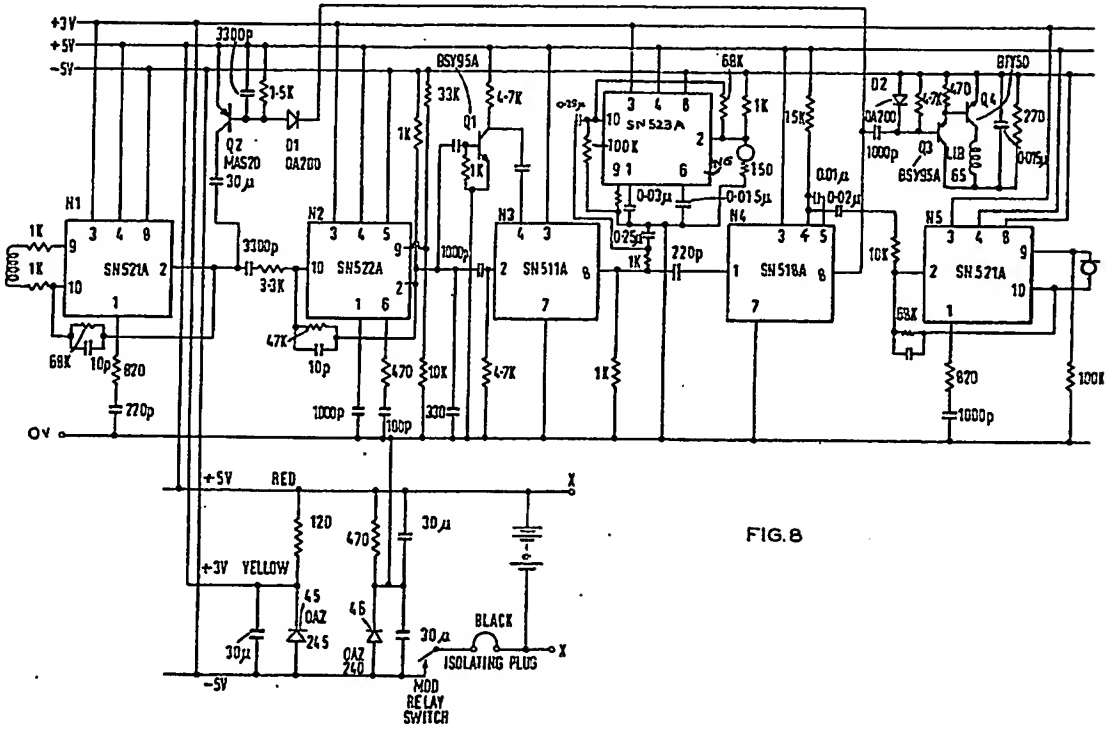
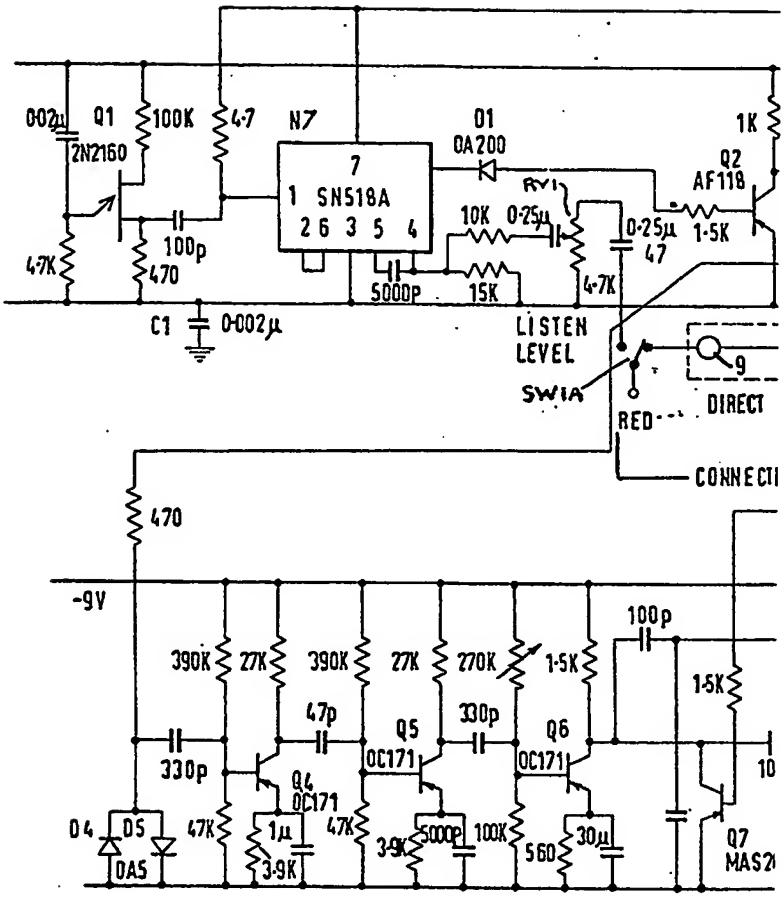

+3V
+5V
-5V
3300p
1·5K
Q2 MAS20
30μ
D1 OA200
BSY95A
33K
4·7K
Q1
1K
68K
1K
15K
BFY50
D2 OA200
1000p
Q3 BSY95A
Q4
270
0·075μ
470
4·7K
N1
SN521A
N2
SN522A
N3
SN511A
N4
SN518A
N5
SN521A
SN523A
100K
150
0·03μ
0·015μ
0·01μ
0·02μ
0·25μ
220p
10K
68K
10p
820
270p
47K
470
1000p
100p
330
1K
0V
+5V RED
X
120
30μ
+3V YELLOW
45 OAZ 245
46 OAZ 240
BLACK
ISOLATING PLUG
MOD RELAY SWITCH

FIG.8


002µ
Q1
2N2160
100K
4·7
N7
7
1 SN518A
2 6 3 5 4
D1
OA200
1K
Q2
AF118
RV1
10K
0·25µ
0·25µ
47
1·5K
4·7K
100p
470
5000p
15K
4·7K
C1
0·002µ
LISTEN
LEVEL
SW1A
9
DIRECT
RED
CONNECTI
470
-9V
390K
27K
390K
27K
270K
1·5K
100p
1·5K
47p
330p
Q5
OC171
330p
Q6
OC171
330p
Q4
OC171
D4
D5
OA5
47K
1µ
3·9K
47K
3·9K
5000p
100K
560
30µ
Q7
MAS2
10

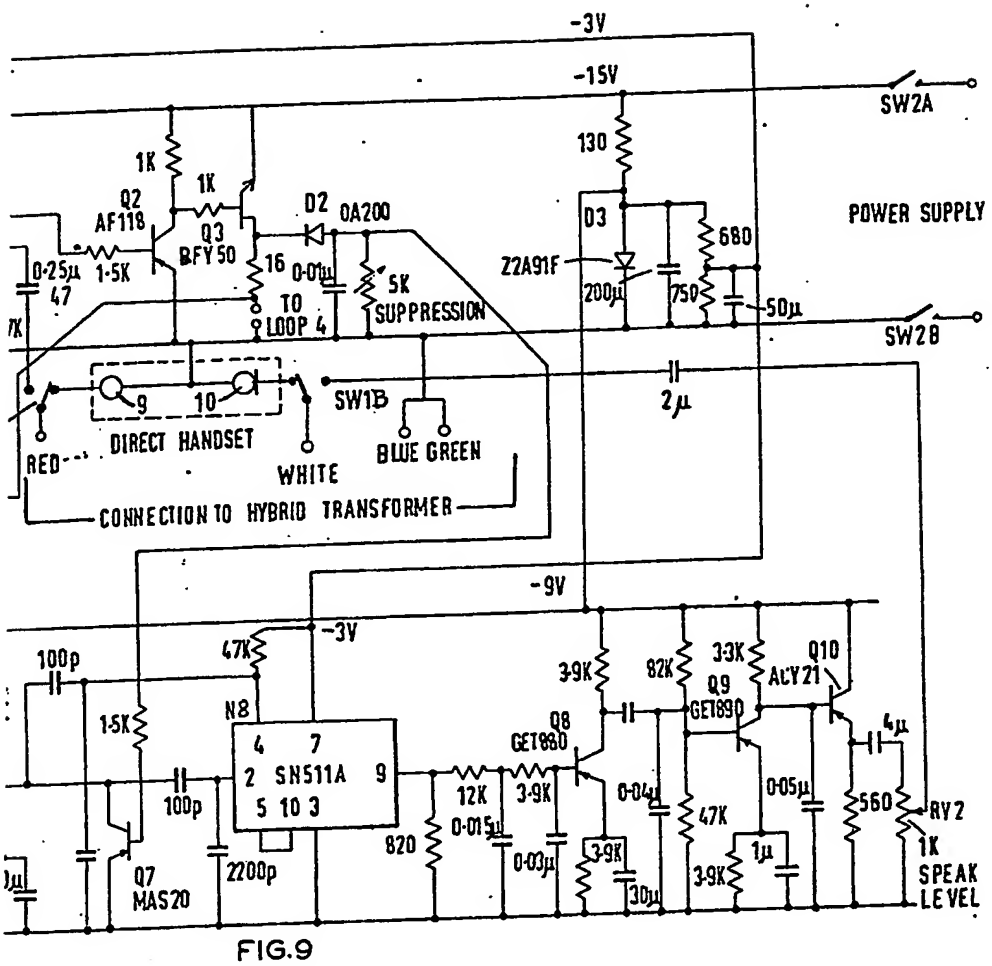

-3V
-15V
SW2A
130
1K
1K
Q2
AF118
Q3
BFY50
D2
0A200
D3
Z2A91F
680
POWER SUPPLY
0·25µ
47
1·5K
16
0·01µ
TO
LOOP 4
5K
SUPPRESSION
200µ
750
50µ
SW2B
9
10
SW1B
2µ
DIRECT HANDSET
RED
WHITE
BLUE GREEN
CONNECTION TO HYBRID TRANSFORMER
-9V
-3V
47K
100p
1·5K
N8
4 7
2 SN511A 9
5 10 3
3·9K
82K
3·3K
Q9
GET890
Q10
ACY21
Q8
GET880
4µ
100p
12K
3·9K
0·04µ
0·05µ
47K
560
RV2
1K
SPEAK
LEVEL
820
0·015µ
0·03µ
3·9K
30µ
3·9K
1µ
Q7
MAS20
2200p

FIG.9

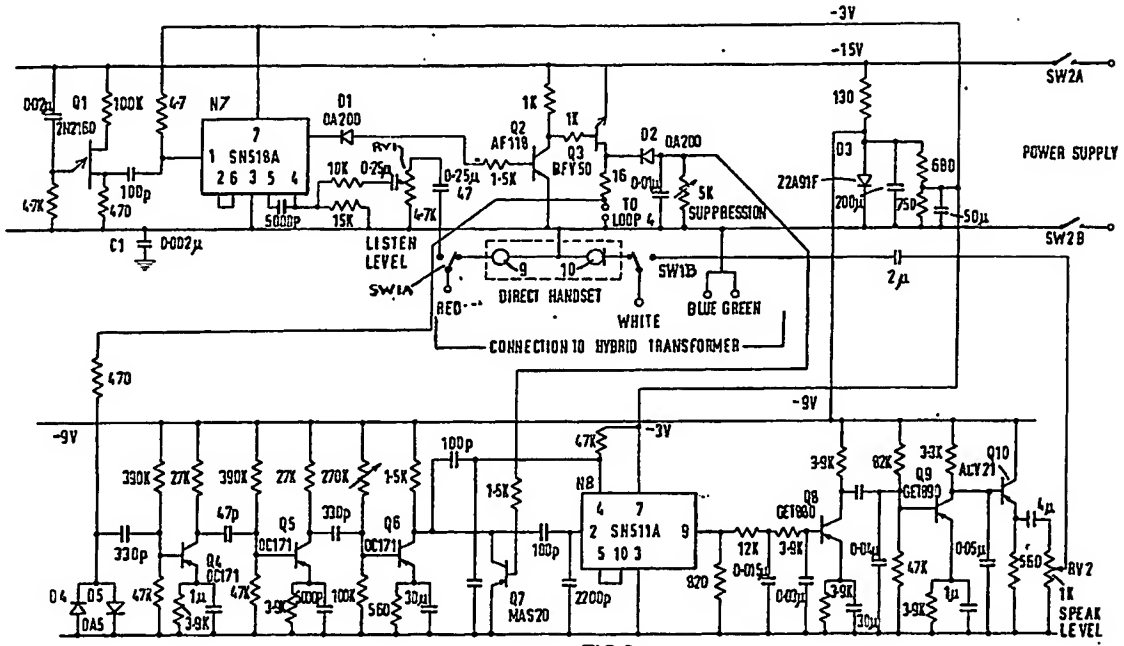

-3V
-15V
SW2A
POWER SUPPLY
SW2B
LISTEN LEVEL
SW1A
SW1B
DIRECT HANDSET
RED
WHITE
BLUE GREEN
CONNECTION TO HYBRID TRANSFORMER
TO LOOP 4
SUPPRESSION
SPEAK LEVEL
-9V
N7
N8
SN518A
SN511A
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
D1
D2
D3
D4
D5
RV1
RV2
C1

FIG.9